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COMMONWEALTH OF AUSTRALIA

Department of Health

SERVICE PUBLICATION (DIVISION OF SANITARY ENGINEERING)

NUMBER 1

SMALL SEWAGE TANKS

Issued by

THE DIVISION OF SANITARY ENGINEERING
OF THE COMMONWEALTH DEPARTMENT
OF HEALTH

UNDER THE AUTHORITY OF
THE MINISTER FOR HEALTH

BY AUTHORITY:

Albert J. Mullett, Government Printer, Melbourne.



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SERIALS ACQUISITION UNIT (S.A.U.)

SMALL BOVAGE

1925

THE COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF HEALTH
SERIALS ACQUISITION UNIT

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DEPARTMENT OF HEALTH

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PREFACE.

The Division of Sanitary Engineering in the Commonwealth Department of Health was organized on the arrival in Australia in December, 1922, of Colonel F. F. Longley, the expert in Sanitary Engineering, loaned to the Commonwealth by the International Health Board.

Among other work which has been undertaken by this Division of the Department is the limited inquiry as to sewage tanks installed in Australia. The subject is deemed to be sufficiently important, and the information available to the public so meagre that the report by Colonel Longley has been issued as a Service Publication, in the hope that the defects of the tanks at present in use may be detected and remedied, and that advice may be available to those who desire to instal an effective system.

J. H. L. CUMPSTON,
Director-General of Health.

PREFACE

The following is a preliminary report of the results of the investigation of the physical properties of the various forms of the substance, and of the effect of temperature and pressure on these properties. The results are given in the form of tables and diagrams, and are accompanied by a discussion of the results.

The investigation was carried out in the laboratory of the Physical Chemistry Department, University of Cambridge, under the supervision of Professor J. H. van't Hoff. The results are given in the form of tables and diagrams, and are accompanied by a discussion of the results.

J. H. VAN'T HOFF

Physical Chemistry Department, University of Cambridge

SMALL SEWAGE TANKS.

By F. F. Longley, D.S.M., C.B.E., Adviser, Division of Sanitary Engineering, Commonwealth Department of Health.

Australia has very few sewerage systems. The metropolitan areas are sewered, but aside from them only a small handful of country towns are provided with this most useful and valuable utility. Human excreta must be disposed of, and until the time when sewerage systems can be built, the pan system is generally used in Australia for this disposal.

The pan privy at its very best is inferior in many respects to a good system of water-carriage. Only rarely is a pan system at its best. It is liable to many defects, and some, or even all, of them are frequently found. Only rarely are the pan contents well covered with absorbent material sufficient to "absorb all foulness, to keep down all odours, and to prevent putrefaction." Most pan privies permit easy access of flies to the pan contents. Many permit the fouling of the soil about the privy. Foul odours from them are very common. The system is recognised as being an unlovely one, but is tolerated mainly because local authorities do not know what other economical arrangement they could substitute in its place, and perhaps because affairs of this kind have been tolerated ever since the dark ages.

THE DEVELOPMENT OF SMALL SEWAGE TANKS.

The common recognition of the defects and dangers of the pan privy and the still more common objections to it based on æsthetic grounds and on the desire to have cleaner, safer, and in all respects better facilities, have resulted in the development of small sewage tanks, or septic tanks as they are frequently called. These tanks permit the use of water flush closets. When operating properly they dispose of excreta and all various liquid domestic wastes without trouble and offence. If favorably situated, the liquids leaving the sewage tank may be effectively disposed of below the surface of the ground.

The degree of purification accomplished by the passage of sewage through such a tank is not very great. Sometimes the liquids leaving the tank are more odoriferous and no less dangerous to the public health than the sewage entering the tank. On the other hand, the effluent is frequently much clearer, and more free from odour than the untreated sewage. The chief result accomplished in the small sewage tank is the separation of the gross solids from the liquids and the

digestion and disappearance of a large part of the organic solids. Where conditions demand a fair degree of purification in the effluent, it is common to pass the liquids immediately after leaving the tank through an oxidizing bed, which improves their quality in a greater or less degree depending upon the sufficiency and perfection of the arrangements.

If properly designed and built and abnormal conditions avoided in operation, small sewage tanks of this sort give such satisfactory results that they have come to be looked upon as very useful and satisfactory means for the disposal of such wastes.

EXPERIENCE WITH THESE TANKS IN AUSTRALIA.

In Australia a great many such tanks have been built during recent years, and many new ones are constantly being built. The majority of them operate well, but here and there one gives trouble. Like the little girl of our childhood verses, "when they are good they are very, very good, and when they are bad they are horrid." The nuisance they create and the trouble they give when they fail to operate satisfactorily, as well as the need which always exists for making these tanks and their operating results safe for the public health, has moved health authorities to give a good deal of study to the problems of these small sewage tanks.

The development of a demand for such installations has resulted in many builders, contractors, plumbers, and architects going into the business of supplying tanks for this purpose, or designs for them. As the successful marketing of such a device requires that the purchaser be convinced of its merits, the builders or designers sometimes make extravagant claims of the special merits of their tanks or of some parts thereof. It is not uncommon to hear the statement that the effluent from such an installation is "pure as spring water," or is "pure enough to drink." There is danger in extravagant statements of this sort, which are distinctly not true. The effluent may be greatly improved in quality in comparison with the influent, but it is far from being a safe liquid to have about. It is not uncommon for the design and the action which goes on in the tank to be shrouded in mystery, but for the average case there should be no mystery about either.

There are a great many types of small sewage tanks advocated. Most of them have certain features quite in common. The variations in type are so numerous that it has seemed worth while to try to obtain a record of experience with many of them, with a view to ascertaining if possible what range of conditions governs their design and operation. Some time ago this division accordingly set about

obtaining such records as it could of the design and the actual behaviour of sewage tanks in Australia. It would seem as though it would be easy to get such information, but it has not proven so. A mimeograph list of items of information wanted was prepared, and a number of these put in the hands of many authorities who had a number of small sewage tanks within their jurisdiction. Some of these have responded in the most helpful way, but others have produced no information. There are a great many tanks which are giving good but inconspicuous service, good, in fact, *because* it is inconspicuous. It is most difficult to learn anything about many of these unless one could make an intimate personal pursuit of such information.

We have, however, obtained fairly complete records of some thirty-eight (38) installations, and the observations made in connexion with them are summarized and discussed herein. It is unfortunate that there are not many more records. These 38 may not safely be taken as representing all types, nor the actual proportion of the various types, but they may serve, nevertheless, to illustrate this discussion.

I take pleasure in acknowledging the help which has been given in obtaining these records by the officers of several of the State Departments of Health, of Departments of Works, and of municipal councils.

THE COMMON FEATURES OF A SEWAGE TANK INSTALLATION.

The common features of a sewage tank installation are as follows:—
A tank of one or more compartments, commonly of concrete; an inlet pipe arranged to permit free inflow of the liquid wastes, with a minimum disturbance of the materials already in the tank; an outlet pipe arranged for the outflow of clarified liquids only. If there is more than one compartment, a passage through from each one to the succeeding one to permit the flow of partly clarified liquids and the retention of the solids; in some tanks baffles to help accomplish this. These tanks are of varying shapes; they are commonly rectangular in plan; they are sometimes of uniform depth, sometimes not. A movable cover is provided for access and a drain for the removal of deposited sludge. In a few tanks one finds stone placed in the last chamber of the tank, continually submerged in the liquids, apparently to aid in the removal of solids. In some installations the effluent flows away from the tank without further treatment. In others it is distributed upon a quantity of stone suitably disposed for the purpose of accomplishing some oxidation and reducing the putrescible characteristics of the liquids. This necessitates means for uniform distribution of the liquids upon the surface of the stone and suitable drainage facilities beneath the stone to carry away the effluent. Ventilation of the sewage tank and the oxidizing bed is provided for in some simple way. Connecting

drains are provided above and below the installation for leading the wastes to, and effluent away from it. There must also be a place for and suitable means for the disposal of the effluent.

WHAT TAKES PLACE IN A SEWAGE TANK.

When liquid wastes flow into the tank the solids tend to settle to the bottom, or, if of low specific gravity, to rise to the top. An active and natural bacterial fermentation proceeds continually in the organic matter of the sewage. This has a certain digestive effect upon the organic solids, causing physical disintegration of a part thereof into an exceedingly fine colloidal suspension, with possibly some liquefaction and gasification of limited portions, and possibly conversion of some portions into more stable compounds. The evolution of gas from the sludge at the bottom causes fragments of the sludge to rise to the surface where they form the characteristic scum. Liquids separated from gross solids then pass on as a tank effluent. The effect of passing through the sewage tank is essentially a separation of liquids from gross solids and a carrying out with the liquids of quantities of finely disintegrated and partly stabilized solids.

The degree of stabilization of the organic matter depends upon the completeness of the installation. Only a limited amount of oxidation and a limited removal of the characteristic of putrefaction takes place in the sewage tank. Sometimes, in fact, the liquids leave the tank more offensive than when they enter it. If the tank effluent is passed through a supplemental oxidizing bed of appropriate design, the degree of stabilization of organic matter is considerably increased.

If by chance the wastes contain pathogenic germs, the reduction of their degree of infectivity is probably not much affected as a result of the clarification in the tank. The clarification would no doubt remove a considerable percentage of those pathogenic organisms present, but there is nothing inherent in the natural processes going on in the tank which would assure anything like complete destruction of pathogenic organisms. A tank effluent without subsequent treatment must therefore always be looked upon with serious suspicion. There is need for definite scientific evidence on this point.

Where the tank effluent is passed through oxidizing beds some additional bacterial purification occurs with corresponding reduction in degree of infectivity. This is probably, roughly, proportional to the degree to which the stabilization of organic matter proceeds. Specific figures to illustrate these statements are not available. Owing to the risk of infection it is not safe, however, to rest on the assumption that the effluent of even the best installation of this sort would be harmless. Every opportunity should be taken to obtain reliable laboratory evidence bearing upon this point.

If the effluent of a sewage tank installation is inodorous and fairly clear, it is commonly considered satisfactory. Since clarification is one of its primary functions, a sewage tank operating with any reasonable degree of efficiency will yield an effluent clearer than the sewage before treatment. The effluent almost invariably flows away in a thin stream, and even if it is a rather dirty liquid when seen in large volume, it is likely to look fairly clear when flowing rapidly in a small stream along a pipe or concrete surface or if examined in a small container. The phrase "inodorous and fairly clear" proves very little except that the liquids are not supercharged with offensive gases of decomposition. It does not prove that the dangerous characteristics have vanished, that pathogenic organisms are no longer present, or that the putrescible organic matter is all stabilized and will produce no further nuisance.

This statement is not intended to belittle the useful results accomplished by a great many small sewage tanks. Their substantial benefits are well enough recognised. It is intended rather to discount the common claims of high efficiency and high degree of safety in the quality of the effluent.

The effluent of a sewage tank not supplemented with an oxidizing bed is satisfactory for certain conditions. For example, where the removal of gross solids is the primary consideration, and a safe and effective disposal of the liquid effluent can be accomplished; as, for example, where reasonably perfect conditions exist for the disposal of the liquids by sub-surface irrigation in porous ground, or by disposal of the liquids by broad irrigation on the surface of a suitably selected area, or discharged into a large body of water in which ample dissolved oxygen exists to suffice for the complete oxidation of the organic matter, and where no question of the safety and comfort of the public is involved. Such a tank effluent is not suitable where there is a liability of exposure of people to any infection carried in the effluent; as, for example, in cases where streams of liquid wastes flow in street channels, tempting barefooted children to play therein; or the case of a water supply from a surface source into which such an effluent flows; or where drainage conditions beyond the tank result in the detention of the effluent in a way to permit secondary putrefaction of the organic matter not already completely stabilized.

The question naturally occurs as to how we can determine the sufficiency of tank treatment; what standards are there to work to; what requirements have been set or might be set.

The most common criterion is that of freedom from nuisance from objectionable odours, and long continued operation without troublesome interruption by clogging with solids. If a tank meets these requirements, it accomplishes one of its chief purposes. If, in addition, the

effluent is disposed of without possibility of contact with humans, there is no need for any better criterion, no need for any precise scientific basis of measurement of the degree of purification accomplished. There are situations here and there, though, in which a knowledge of the quality of the effluent, of its power of putrescibility and the chances of its containing active germs of disease would be of great value to authorities who bear the burden of responsibility for the health of communities. Sewage tank effluents flow into street channels in many Australian towns. Here and there the children play in these streams, foul odours from them are a frequent cause of complaint, and in some cases such liquids flow into streams used for water supply.

Considering all these conditions, it would be most helpful if there were an extended array of scientific facts derived from laboratory examination, to show just what degree of bacterial and organic purification does take place in small sewage tank installations. It is difficult to find records of laboratory tests on the performance of small installations of this sort, and no opportunity should be missed where the conditions are at all favorable to obtain laboratory information both chemical and bacteriological.

ANALYSIS OF RECORDS OF 38 SEWAGE TANK INSTALLATIONS.

On the inserted sheets are given the records of the 38 installations so that any one wishing to may study them in detail.

Number of Chambers in Tanks.

Of the 38 tanks of which records are at hand twelve have only a single chamber, twenty-one have two chambers, one has three chambers, and none is stated to have more than three. Many types of small sewage tanks advocated by health authorities, architects, &c., have only a single tank. The advantages of more than one chamber for the process of separation of solids from liquids do not seem obvious. On the other hand, there do not seem to be any particular disadvantages in passing the liquids successively through the two chambers of the tank excepting that of one additional chance of clogging of passages taking place.

Capacity of Sewage Tanks.

A nice selection of suitable capacity for a sewage tank always appears to be one of the most important points considered by tank designers. If there were approximate agreement on the part of all designers or builders of tanks as to what is the most suitable capacity, it would be natural to accept it as a standard without serious question. I have taken out a record of capacities of small sewage tanks recommended by various authorities. Broadly speaking, these vary from a minimum of 20 gallons to a maximum of 100 gallons *per capita* without

any apparent explanation for the wide range of values. Let us look at the record of capacities of the 38 tanks which are the subject of this examination. The minimum capacity is 7 gallons *per capita*; the maximum is somewhat over 500. This maximum, however, is a special case of a tank built for a large number of people, but only used actually by a small number. The comment regarding it is that its operation is most satisfactory, that there are no bad odours at any time, and that the exceptionally good effluent is accounted for by the present small population (*i.e.*, the large unit capacity). The next largest is 100 gallons. About one-quarter of the lot have capacities ranging from 70 to 100 gallons *per capita*, another quarter from 40 to 70, another quarter from 22 to 40, and the other quarter less than 22 gallons *per capita*. The tanks which are noted as giving unsatisfactory results are scattered generally through this range, and do not apply principally either to the high or to the low values of tank capacity. In view of this evidence, one can only conclude that there is no fixed figure for tank capacity which can be depended upon to give markedly better results than capacities considerably higher or lower, but that tank capacity lying almost anywhere between 20 and 100 gallons *per capita*, or perhaps even more or less, will give satisfactory service, providing proper attention is paid to features of design and construction.

I have sought a long time, and sought in vain, for facts which would show the scientific basis for the capacities which designers and builders of sewage tanks commonly advocate; that is, facts which would serve to prove that a capacity greater than a certain quantity or less than a certain quantity would fail to give good results. The factor which probably carries greatest weight is the length of time the sewage is detained in the tank. If, for example, a tank were built with a capacity of 20 gallons *per capita*, and the sewage flow amounted to 100 gallons *per capita* per day, the period of detention would be only about five hours. If, on the other hand, the tank were designed with 100 gallons *per capita* capacity, and the quantity of sewage amounted to only 20 gallons *per capita* per day, the sewage would be detained in the tank for a period of about five days. Both these illustrate conditions which seem extreme. Experience with small sewage tanks, supported by general experience with larger tanks for municipalities, indicates a period of detention of 24 hours more or less as a suitable one to encourage a reasonable disintegration and disappearance of the solids. It may, therefore, be kept in mind as a useful criterion in fixing the tank capacity.

The available records of the 38 tanks do not suffice to show the relation between tank capacity and quantity of sewage flowing. It would be interesting to know just what it is on the average, and what the longest and the shortest periods are. It is well to bear in mind

the fact, though, that there is no precise basis for stating 24 hours, for it is well known that periods both longer and shorter than that will give satisfactory results in small sewage tanks. Twenty-four hours, in fact, is not stated here as "the most suitable period," but as "a suitable period," which has the merit of considerable support in actual experience.

Depth.

The depth is commonly considered as having some significance. There must be depth enough for the storage of the deposited solids and also for the mass of floating solids which constitute the scum, and a space between for the flowing liquids which will result in their being detained a suitable length of time for the solids to separate. In looking over the designs of numerous tanks it is logical to expect the depth to vary somewhat with other dimensions, and therefore a direct comparison of depths of numerous tanks does not mean very much. Nevertheless, one wants some kind of index of relative depth. The difference between tanks of great depth and of small depth in relation to capacity may be judged by a comparison of their more significant dimensions; for example, the actual depth may be compared with the side of a cube having the same cubical contents as the tank.

A computation of this sort has been made for each tank examined, and the resulting figure will be referred to here as the index of relative depth. There is a wide variation in this index of relative depth, the maximum being 1.88 times as great, the minimum only .37 times as great, and the median .70 times as great as the depth of a cube of capacity equivalent to the tank. From the record of these 38 tanks it is difficult to draw any conclusions as to whether a deep tank or a shallow tank has any special advantages. The tanks which are noted in the record as giving unsatisfactory results for any reason do not lie consistently among either the highest or the lowest values for this depth index, but are scattered generally through the entire range. As a matter of fact, about two-thirds of the tanks recorded as not operating satisfactorily have depth indices nearer the median in value than either the maximum or minimum.

Kinds of Wastes Treated.

The practice varies regarding the kinds of wastes which are led into a sewage tank. In some cases it is human wastes alone, in other cases human wastes and various other liquid domestic wastes, such as sink and bath drainage. In nineteen of the installations the wastes treated consist of human wastes only. In seventeen other installations they consist of human wastes and bath wastes, kitchen wastes, &c. In the case of eleven hospital installations they include all ordinary hospital wastes as well. It is general practice, however, to avoid putting disinfecting solution into the tank in hospital installations.

The decision as to the kinds of liquid wastes to be permitted to flow into the sewage tank involves the question of what safe and effective disposal can be made of any of these wastes if not passed through the tank. Human wastes are usually the primary constituent. Sullage waters from sinks, baths, &c., may be highly putrescible, but do not carry so much gross solids in suspension. If the disposal of the tank effluent is safe, simple, and thorough as in underground distribution in an absorbent soil, there may be an advantage in putting sullage waters through the tank along with domestic sewage. For one thing it has the merit of simplifying piping and concentrating the means of disposal. Broadly speaking, however, it may be said that sink wastes, bath wastes, &c., will not be in any sense *purified* by mixing with domestic sewage, and passing through a sewage tank, although their characteristics may be somewhat changed. If the tank effluent is subsequently treated upon oxidizing beds these wastes may advantageously be delivered into the sewage tank with human wastes and passed through both sewage tank and oxidizing bed.

It is of utmost importance to exclude grease both from the tank and oxidizing bed by the use of suitable grease traps. Disinfectants, strong acids, &c., have frequently been known to interfere seriously with the biological action proceeding in the tank. Likewise, if large quantities of water heated to very high temperature are habitually run into the tank they may interfere with biological activity. Storm water, that is rain water drainage from roofs, yards or courts, should not be led into a sewage tank, as the large quantities and high velocities would be very liable to disturb the normal biological processes.

Information regarding Cleaning of Tanks.

Of the 38 tanks of this record three give no data regarding cleaning; eight are reported never to have been cleaned out. Of these one tank has been in use for five years, two for four years, two for three years, one for two years, and two for one year. The remaining 27 tanks, constituting 71 per cent. of the total, have been cleaned out from time to time. Fifteen of these, or 40 per cent., have been cleaned out within a year or less. Twenty-two of them, or 58 per cent., have been cleaned out within two years or less.

Remarks on Operation of Tanks.

Eleven tanks out of the 38 are noted as not working satisfactorily. The reasons given for this are as stated on the summary sheets. In most cases the reason for unsatisfactory operation seems clearly indicated. In a few cases the reason for the troublesome operation does not appear from the evidence.¹ Certain other cases of unsatisfactory operation which are now and then met with are referred to elsewhere herein.

Disposal of Effluent.

In fifteen of the 38 installations the final effluent is discharged direct into a stream or other large body of water. In four of these the tank effluent is passed through an oxidizing filter. In nine other installations the final effluent is disposed of on the surface of the ground, and in six cases out of the nine the tank effluent is passed through an oxidizing bed before final disposal. In twelve other installations the final effluent is disposed of beneath the surface of the ground, and in five of these the tank effluent is passed through an oxidizing filter before final disposal. In one case the effluent goes direct into a street channel.

SEWAGE TANK TROUBLES AND MEANS OF AVOIDING THEM.

There are various ways in which a sewage tank may be troublesome, among which are the following:—

1. Its design and construction may be wrong.
2. Its design and construction may be satisfactory, but it may be unfortunately placed with reference to its surroundings.
3. The openings for the flow of liquids may become stopped up.
4. There may be an excessive accumulation of solids.
5. The cleaning out of the tank may be left too long.
6. There may be objectionable odours.
7. There may be troubles with oxidizing beds attached to the sewage tank.
8. Stoppages may occur in the drains connected with the tanks.
9. The disposal of the effluent may be imperfect.

A discussion of these troubles, their causes, and means of avoiding them, appeals to me as being a useful means of guidance in arriving at suitable designs and satisfactory conditions of operation.

If a tank is designed along rational lines a good beginning is made towards satisfaction in its use. And what are "rational lines"? Some idea of this is indicated by the preceding discussion of the record of the 38 installations, but I will here take it up more specifically.

In the design of a sewage tank the following are the outstanding controlled conditions:—

1. The kinds of wastes, whether human wastes only, or whether other domestic wastes; and whether any wastes are likely to be included which might interfere with biological action in the tank.
2. The degree of purification required governed by conditions relating to the ultimate disposal of the sewage liquids after they leave the tank.
3. The number of people contributing sewage.

4. The probable quantity of wastes.
5. Conditions at the point of disposal, and especially the character of the soil if it is to be used for the ultimate disposal of the liquids.

Items 1 and 2 are matters for careful consideration and judgment, and the remarks on these points elsewhere herein may be helpful in arriving at logical conclusions. Items 3, 4, and 5 are matters of fact, or of estimate based on fact.

Let us assume that decisions have been reached regarding these items. that the tank capacity has been fixed equal to the estimated 24 hours flow, and, unless there is some condition fixing it otherwise that the depth is to be .70 times the side of a cube of contents equal to the tank capacity. Nicety of construction must now be an important consideration. The tank is intended to detain the sewage solids at the bottom and in the scum. There should be no accidental opportunity for detention of the solids at any other points. I have reference in particular to smoothness of joints in drains and connecting pipes, the avoidance of sharp bends in the pipe, the avoidance of projecting ledges upon which sewage solids might be deposited.

Stone is sometimes placed in a final compartment of the sewage tank, as though to aid in the removal of suspended solids. Stone submerged continuously in sewage liquids cannot be expected to accomplish any measurable additional purification, although it may have a limited value, somewhat comparable perhaps to additional baffling, in catching a small amount of suspended solids which might otherwise go out with the tank effluent. It can serve thus, however, only at the risk of clogging and interference with the routine of tank operation.

It is of the utmost importance that a sewage tank, no matter how well designed, should be set in such a position that the flow of the liquids through it may proceed at all times without interruption or interference, and so that it cannot be submerged or in any way unfavorably influenced by surface drainage during rainy periods. I recently saw an example of this sort. A small sewage tank has been designed along lines approved by a State authority which prides itself on its knowledge of, and its control over, small sewage tank installations. The tank was built, however, in the middle of a horse yard back of the stables in a depression in the ground from which there was no natural drainage. Whenever it rained the surface drainage filled this depression to a depth of several inches, completely flooding the sewage tank and interfering seriously with its normal behaviour. A small hand pump had been placed to permit some of the flood liquids to be pumped out of the tank; but this was a futile remedy for a defective setting of the tank, as it was bound to fill up again quickly as long as the pool of surface drainage stood all about it.

One of the commonest difficulties found in small sewage tanks is the clogging of the openings through which the liquids are supposed to pass. This sometimes occurs as a result of excessive accumulation of scum about the outlet. It frequently occurs as a result of the presence of grease, which tends to stick to the inner surfaces of the openings, forming a surface to which other solids will readily adhere; and this process may go on until the opening is greatly reduced in size if not completely shut off. I have recently seen a number of cases of this sort. Occasionally rags, heavy papers, &c., drift into the openings tending to clog them. Sharp bends in connecting pipes are likely to contribute to trouble of this sort. Likewise rough joints, scraps of plaster left within the pipes, or ragged edges of the pipe are likely to add to the difficulty. This, of course, must all be carefully guarded against. Many designers pay close attention to the accessibility of every opening through which the sewage must flow. Where this is neglected it makes it exceedingly difficult to clear out stoppages of this sort. Oftentimes the cleaning out of the passages is all that is necessary to convert a troublesome tank into a satisfactory one.

As already mentioned, troublesome conditions in sewage tanks are now and then occasioned by permitting too great an accumulation of solids. Sometimes the accumulation on the bottom of the tank may be too great, sometimes that at the top. It has sometimes been observed that if a tank with a large accumulation of solids receives for a time a considerably smaller quantity of sewage than is usual, the thickness of the scum diminishes. It would be only under unusual conditions, however, that this fact could be taken advantage of for reducing the accumulation of solids in the tank.

Trouble frequently results from neglecting too long the cleaning out of the tank, that is the removal of a large part of the accumulated solids. One frequently hears the statement that a sewage tank digests or dissolves all the solids which go into it. There are, in fact, many tanks so fortunate in design and in conditions governing their operation and behaviour that they run for years without an accumulation of solids which urgently demands cleaning. It is the attempt to attain that condition which moves the designers and builders of all tanks to advocate certain fixed shapes, arrangements, capacities, &c.

The burden of experience shows that the biological action which goes on in the sewage tank does not disintegrate or dissolve all of the solids. It can be safely assumed that there are always some solids which remain in the tank. The conditions which govern this degree of disintegration and the rate of accumulation of undissolved solids are not very well known. They appear to depend somewhat upon the character of the wastes. For example, a small house tank receiving nothing whatever but human excreta appears to accumulate solids at

a very slow rate. Larger tanks, however, receiving the mixed sewage of towns, of institutions, of hotels, &c., accumulate solids at a considerably greater rate.

The fact that tanks require the removal of solids now and then must be recognised. Those who have tanks operating well for many years without cleaning may consider themselves fortunate, but at the same time they should not rest complacently in the belief that they will never have to be cleaned out. The record of tank cleanings among the 38 installations as given above is interesting in this connexion.

A sewage tank frequently gives trouble from objectionable odours. In a normal condition of operation with an undisturbed scum and a tank operating well there are likely to be no serious odours. There is always the musty or earthy odour and a certain odour of stale organic matter, but generally speaking no objectionable odours of putrefaction unless some abnormal condition exists. The bacterial processes which go on in the tank commonly result in the complete exhaustion of oxygen, especially in the sludge at the bottom of the tank. When from time to time this sludge must be removed and disposed of it may be highly offensive. Grease in excess in the solids deposited in the tank may putrefy and cause most objectionable odours. This emphasizes the importance of grease traps for intercepting the grease before it reaches the tank. Strong chemicals or disinfectant solutions which find their way into the tank may kill great numbers of bacteria, and this may result in a development of objectionable odours. When the tank is operating satisfactorily the bacterial fermentation therein is carried on by myriads of bacteria of certain kinds which are effective and beneficial for the processes in which they are involved. If they are suddenly killed off in enormous numbers, rapid multiplication may occur of some of the numerous other forms of bacterial life which are always to be found in sewage. Some of these which thus find accidental opportunity to develop and dominate the bacterial life of the tank may have the power of splitting off from some of the unstable compounds of organic matter, gases which are highly odoriferous and objectionable; and may also completely prevent for the time the favorable action of digestion and disintegration of the organic matter which is the normal condition in the sewage tank.

If the normal performance of a sewage tank is interrupted by stoppage of openings, excessive accumulation of solids, or other such cause, troublesome odours are likely to develop. The remedy, obviously, would be to establish conditions which would always assure uninterrupted flow.

An oxidizing filter used for the treatment of the tank effluent is liable to a number of defects. It can give trouble from bad odours, from excessive growths of weeds clogging the surface, from clogging

of the material below the surface, &c. Ample capacity and uniform distribution of the liquids over the surface are the primary requisites. Many troubles arise from poor distribution. It results in a concentrated flow through certain portions of the oxidizing bed which thus carry an excessive burden, while other parts carry little or none. Inefficient oxidizing action may result. Clogging of the material below the surface and growths of weeds upon the surface are likely to follow this condition. A free flow and as uniform a flow as possible over the stone is of greatest importance. It seems to be important, too, to prevent grease from reaching the oxidizing beds.

Cases are occasionally met with where the sewage tank and, perhaps, an oxidizing bed following it are well designed, well built, and operating satisfactorily, and yet trouble occurs after the effluent leaves the installation altogether. If the effluent from such an installation could get away promptly, and without any detention, into a stream of suitable volume and purity to effectively dilute it, or into the soil in a safe and effective way, no objectionable conditions could arise. One now and then finds such an effluent flowing in surface drains which are very flat and irregular of contour, permitting the ponding up of liquids containing substantial quantities of putrescible organic matter. In every little pool so formed putrefaction proceeds, and sometimes a whole neighbourhood suffers from troublesome odours as a result thereof. In flat surface drains sometimes a small rag, a bit of paper, or some dead leaves or grass are sufficient to cause a ponding up of the liquids and a resulting development of troublesome odours.

An effluent can be disposed of below the surface of the ground only if the condition of the soil is favorable. Sand or sandy loam or any highly porous soil will dispose of a considerable quantity of effluent from the sewage tank. It is well to remember that grease accumulating on a soil surface soon renders it impervious, and therefore grease must not be permitted to reach this point. Impervious soils such as clays or heavy clayey loams are unfavorable for the disposal of liquids. It is not an uncommon thing to find sub-surface drains or sumps intended for the disposal of tank effluent and located in impervious soil, which have failed miserably to effectively dispose of the liquids.

A STATEMENT OF PRINCIPLES.

The trend of this discussion seems to point to a number of principles somewhat as follows:—

1. Experience shows that the *per capita* capacity of tanks operating satisfactorily varies through a wide range. The inference which we can draw from this is that a nice determination of capacity in gallons *per capita* is not of nearly so great importance as assuring perfection of design and construction in various other details,

2. Certain important points regarding which great pains should be taken in design and construction are as follows:—
 After fixing the general type, the dimensions and the depth, particular care should be given to accessibility of all openings or passages for sewage, the avoidance of sharp bends in piping, the avoidance of rough interior surfaces of drain pipes, and of other openings through which the sewage must pass, especially at joints and angles, the assurance of suitable grades for the drains to and from the sewage tank, the assurance of perfect conditions if the effluent is to be distributed below the surface of the ground, the assurance of perfect distribution of the tank effluent upon the surface of the oxidizing filter, if any.

3. Certain important points in which special care should be taken in operation and maintenance of the installation are as follows:—

The tank should be inspected from time to time by some one competent to detect whether any condition is developing which is likely to become troublesome.

The drains must be maintained clean and with a free flow.

The passages or openings for the sewage within the tank must be kept clean at all times.

In the event of excessive accumulation of solids, whether at the top or the bottom of the tank, a suitable portion should be removed before the accumulation becomes troublesome.

4. Excepting for certain favorable and unusual combinations of conditions, an accumulation of solids may be expected in every tank, which will have to be removed from time to time. These favorable combinations of conditions are not definitely known, but it is known that many small tanks receiving human wastes only run for many years without an accumulation of solids great enough to demand cleaning out.

5. It is far from safe to assume that the effluent of a sewage tank installation is pure and innocuous, and where it cannot be disposed of without risk of contact with humans it must be considered as a source of possible infection.

6. It is important to recognise the fact that, while of great value for residences, institutions, &c., where sewerage is not accessible, the sewage tank installation is not a complete and satisfactory substitute for a water carried sewerage system for a community.

7. It is desirable to have laboratory examinations made of sewage tank effluents in cases where this can conveniently be done in order that scientific facts may be accumulated for a further study of this important problem.
8. It is desirable to obtain numerous other records of design and operation of small sewage tanks to increase the value of such a study as is here attempted.

I have considered the advisability of reproducing the many designs of sewage tanks which are advocated by health authorities, engineers, and architects. If this were done I am inclined to think it would only result in confusion, as many of them differ widely in type. I would hesitate to single out any one type and say it is the best. I would hesitate still more to presume to add another new design, claiming it to be the best, for the only justification for doing that would be to present something distinctly better than now existing, and that would be difficult, for many of the types now recommended are excellent. With any type of installation which includes the essential features of rational design, the chances of satisfactory results can be increased by thorough and careful study of the conditions about the tank, and by taking pains to avoid some of the common causes of troublesome operation such as are set forth above.

DATA CONCERNING SMALL SEWAGE TANKS.

A. Tanks which are stated to be operating satisfactorily.

A. Tanks which are stated to be operating satisfactorily.																													
Tank	Water Line Measurements				Average Depth from Water Line	Index of Relative Depth	Total Capacity of each tank	Is sketch or blue print attached through a filter?	Description of Disposal of Effluent	Kind of Service	No. of Persons				Nature of Wastes	When built	When last cleaned	Quantity of Solids removed	Quantity Left	Covering of Tank	Manholes etc.	Ventilation	Thickness of Scum	Does Scum obstruct opening?	Depth of Sludge	Are there objectionable odours?	Description of Effluent	Is there a grease trap?	Remarks
	Total Length at Water Line	Lengths of Separate Compartments	Width	Height							Maximum	Average	Minimum	Capacity in galls. per capita.															
1	3' 8"	1' 10"	3' 1"	4' 3"	.73	9015. 1st ch. 140 2nd. Ch 60	Yes	Discharged on surface of black, grass-covered soil. Steep waste land. Satisfactory.	Boarding Establishment	45	20	12	7	W.C. wastes only.	1906	Sept 1921	20	0	Top level with ground and covered with planks.	Whole top readily uncovered	No Special Ventilation	3	No	18	No	Clear, light greenish.	No	Satisfactory	
2	Three Separate Tanks	24'	10'	6'	.53	1440 c.ft.	Yes	Discharged on surface of sandy soil. Satisfactory.	Hospital for Insane	1,100	1,100	1,100	24.55	W.C., Kitchen, Bath and Hospital Wastes	1908	Jan 1923	753	10	Concrete Roof	Two manholes for each tank	Two 9-in. and one 6-in cowls 12 ft in height	3	No	3 to 6	Never very strong	Fairly clear and light coloured	Yes	Tanks work satisfactorily and no actual stoppage has been observed. No interference with Septic Action has ever been observed. Odours are never objectionable.	
3	Three separate tanks	17' 6"	7' 6"	5' 6"	.61	722 c.ft.	Yes	Discharged into drain via Swan River. Not satisfactory owing to leak down of filter.	Domestic (Old Men's Home)	620	600	580	22.55	W.C., Kitchen and Bath Wastes.	1904	Jan. 23	918	12	Amended 1920 May 22	One manhole at outlet end.	Standard 4" ventilators 12' high	2-3	No	2-3	No	Fair only	Yes	No 3 tank not in use. No stoppages, no objectionable odours, septic action not interfered with.	
4	Two separate Tanks	16'	6'	5' 3"	.67	472 c.ft.	Yes	Discharged on surface sandy soil. Satisfactory	Hospital	—	80	—	73.75	W.C., Kitchen, Bath and Hospital Wastes (containing disinfectants.)	1910	Jan 1917 & 1923	185	10	Altered 1921-22	Two manholes on each tank.	Two 5" x 3" vents from each tank carried to 6" No 2 ventilator 11' high 0'-1"	No 1	No	0	stronger than from other installations	Clear; light colored	Yes	Operation satisfactory; sewage carriers require cleaning daily; thickness of scum kept within bounds by periodical removals at outlet end.	
5	10'	—	5'	5' 9"	.87	287.5 c.ft.	No	After bed below ground level. Thence S.W. pipes to Mulhally. Satisfactory	Hospital	160	111	86	16.04	W.C., Kitchen, Bath and Hospital Wastes	1902	Feb 1922	27	10	Concrete Roof.	One M.H. at centre. Openings at each end.	6" standard ventilator 45' high	9"	No	3"	No	Fairly clear, cloudy	Yes	Satisfactory. Scum removed from outlet end from time to time.	
6	8'	—	5'	5' 8"	.93	225.6 c.ft.	Yes	Discharged via S.W. and C.I. pipes to Swan River. Satisfactory.	Hospital	—	27	—	52.2	W.C., Kitchen, Bath and Hospital Wastes (No Disinfectants)	1920	Dec 1922	67.5	3	Concrete Roof	One manhole	4" standard ventilator 12' high	2.6"	No	2.4"	No	Clear and light coloured	Yes	Satisfactory	
7	10'	3'	10'	5' 1"	.68	425 c.ft.	No	Under ground. Satisfactory	Domestic (War time)	200	5	3	531 (13.28 max)	W.C., Kitchen and Bath Wastes.	1914	June 1922	72.9	5	Covered	Each compartment has a M.H. and that adjoining Filter has 3.	No ventilation for tanks	1'-6"	No	0	No	Clear as water, light coloured	Yes	There are two tanks of equal capacity operating most satisfactorily. No bad odours at any time. The exceptionally good effluent is attributed to the present small population.	
8	Two Circular Tanks	2' 6"	2' 6"	4'	.148	1964 c.ft. (each)	Yes	Underwater, Swan River. Satisfactory	Public Conveniences	No	Record	Rept.	—	W.C. and Urinal.	1915	Dec. 1922	No. 1, 3.42; No. 2, 1.71	No. 1, .25; No. 2, .25	Covered by movable concrete slabs.	Cover	2" pipe ventilator 11' above Jetty	No. 1, No. 2	No	0	No	None obtainable	No	These tanks are installed on the Mend Street Jetty, Perth, W.A. and effluent is discharged directly into the Swan River. Excellent results. Only trouble has been partial choking of outlet by shell fish in the water.	
9	8'	—	5'	4'	.74	160 c.ft.	Yes	On surface of loamy soil. Irrigation of fruit trees.	Hospital	—	35	—	27.57	W.C., Kitchen, Bath and Hospital Wastes	1914	June 1922	66.4	1.5	R.C. Roof	One manhole at outlet end	2 1/2" G.I. vent pipe.	16"	No	0	At times effluent gives off objectionable odour.	Fairly clear, light coloured	Yes	Operation of tank is satisfactory. Disposal of effluent is unsatisfactory owing to the earth ditch becoming blocked. Lack of attention is responsible for this.	
12	14'	14'	6'	6'	.75	504 c.ft.	Yes	Under ground. Subsurface system. Satisfactory	Hospital	—	—	—	—	W.C., Kitchen, Bath and Hospital wastes containing disinfectants.	1909	See Remarks	—	—	—	One manhole	3" G.I. vent.	See Remarks	No	A few inches	No	Clear	Yes	Operation satisfactory. Scum removed annually. 12" to 15" thick.	
14	14'	14'	4'	5' 4"	.82	280 c.ft.	Yes	Stone pitched street channel. Satisfactory.	Hospital	—	25	—	70	W.C., Kitchen, Bath and Hospital Wastes	1906	1918	—	—	Concrete cover	Movable slabs	Pipe with exhaust vents	1 1/2" to 1 3/4"	No	A few inches	No	Clear	Yes	Satisfactory with comparatively little attention.	
15	6'	6'	4'	4'	.87	96 c.ft.	Yes	Discharged down old mine shaft.	Hotel	—	50	—	12	W.C., Kitchen, Bath and Hotel Wastes	1909	see Remarks	—	—	Movable concrete cover	Movable concrete cover.	Pipe with exhaust vent	See Remarks	No	A few inches	No	Clear	Yes	Scum is allowed to reach thickness of 12" to 18" and half of it is then removed. Plant operates satisfactorily subject to proper attention.	
18	25' 6"	20' 0"	9'	4' 6"	.37	1806 c.ft.	Yes	Discharged into a running stream. Satisfactory.	One treatment works	—	187	—	62.3	No other discharge	1916	Oct. 1920	Not known	None	Timber and clay top	Top readily removed	None	4"-5"	No	Seems to have none	No	Slightly turbid, light colour.	No, but no grease	Tank works well.	
20	5' 9"	2' 10 1/2"	3'	1' 6"	.54	21 c.ft.	Yes	Through 1 1/2" of 4" pipe to open ditch, thence percolates through soil. Satisfactory	Domestic	5	5	5	26	W.C. only.	1920	Not yet cleaned	—	—	—	One manhole	Induct vent and educt vent	9"	No	2"	No	Clear and light coloured	No	Very satisfactory.	
22	6'	4' 2"	4'	3' 6"	.80	84 c.ft.	Yes	Into underground drain carrying large amount of storm and household water to river.	Domestic	10	8	4	51	W.C. only.	Jan. 1923	Not yet cleaned	—	—	—	Two openings 4' x 4' & 4' x 2'	Two vents.	4"	No	1/2"	No	Clear and light coloured	No	To all appearances, satisfactory.	
25	22'	14' 8"	14' 4"	6' 1"	.58	1881 c.ft.	Yes	Through underground pipe to sea.	Domestic	350	310	380	33	W.C. only.	1919	Not yet cleaned	—	—	—	Four Manholes	Side-vent and outlet vent	36"	No	6"	No	Clear and light coloured	—	Very satisfactory.	
26	3' 8"	1' 10"	3' 8"	2'	.73	21 c.ft.	Yes	Into soakage well or sump. Clay with layers of pervious sand.	Domestic	3	3	3	18.75	W.C. only.	Aug. 1920	Not yet cleaned	—	—	—	—	—	8"	—	1"	No	Clear	—	Very satisfactory. One block in pipe from W.C. to tank on March 14th, 1922. No other stoppage.	
27	7'	Clear. 3' Solid 4' (1)	3'	3' 6"	.40	Overall 77 c.ft. In use 62.5 c.ft.	No	do	Domestic	4	4	4	82	W.C. only	May 1921	Not yet cleaned	—	—	—	—	—	7"	—	3"	No	Clear	—	For the first three months of operation the odour was very strong. Since then there has been no odour and the tank has worked very efficiently.	
28	Anaerobic chamber 4' dia. x 4' deep. Aerobic chamber 4' x 6' x 4' 3" deep.	—	—	—	—	50 c.ft. 105 c.ft.	do.	No	Into underground drain which discharges into an arm of the sea	Hotel.	25	18	10	54	W.C. only	About 1903	Jan. 1922	51 c.ft.	—	—	—	8"	—	6"	No	Clear	—	Has worked satisfactorily since it was remodelled in 1918. Faults corrected were 1. Right angled bends in discharge pipe 2. Circular (anaerobic) tank too small	

A(cont) Tanks which are stated to be operating satisfactorily.

Tank	Waterline Measurements			Average Depth from waterline	Index of Relative Depth - Volume	Total Capacity of each tank	Is sketch or Blueprint attached	Is effluent passed through a filter?	Description of Disposal of Effluent.	Kind of Service	No. of Persons				Nature of Wastes	When built	When last cleaned	Quantity of Solids removed	Quantity left	Covering of Tank	Manholes etc.	Ventilation	Thickness of Scum	Does scum obstruct openings?	Depth of Sludge	Are there objectionable odours?	Description of Effluent	Is there a grease trap?	Remarks.
	Total length at waterline	Length of Separate Compartments	Width.								Maximum	Average	Minimum	Capacity in gals. per cap.															
31.	12' 4"	6' 7" 5' 8"	4' 5"	3' 2"	.57	171 c.ft.	Yes	No	Into drain pipe to Corporation drain, thence to Sea.	Restaurant and Boarding House. School and Convent	30	19	8	56	W.C. only (P)	Jan. 1918	Not yet cleaned	—	—	Cement top forming part of yard.	One M.H. over dividing wall.	Goose neck 2' high. Air shaft 7' high.	12"	No	0	No	Clear, slightly smoky light colour	—	Very satisfactory
32.	14' 9"	6' 4" 8' 0"	4'	3' 7"	.61	206 c.ft.	do.	No	do.	do.	60	67	74	19.2	W.C. only	1910	Sept. 1919	81 c.ft.	15 c.ft.	Portion of Tennis Court	One M.H.	Goose neck 2' high. Air shaft 8' high	8"	No	2"	No	Light and clear. Faint opalescence	—	Was very unsatisfactory while discharging into a sump; but since it has discharged into drain it has been very satisfactory. Rather inadequate in size.
33.	12'	5' 9" 6' 3"	5'	3' 8"	.65	180 c.ft. (P)	do.	No	do.	Railway sheds & yards	60	45	30	25	W.C. only.	1917	Dec. 1919	54 c.ft.	1 c.ft.	About 3" of soil.	Two manholes	One vent pipe or at each end. 5' and 7' high	—	Yes	none	No.	Fairly clear; bluish tinge.	—	Working well, but scum gradually builds up and has to be removed from time to time.
36.	7' 6"	4' 3' 6"	3' 6"	3' 8"	.80	96 c.ft.	do.	No	Soakage pit in sandy soil	Domestic	6	6	6	100%	W.C. only	1918	Dec. 1922	81 c.ft.	—	—	Two manholes	Two vent pipes 2' and 7' high resp.	2"	No	none	No	Clear, light coloured	—	Satisfactory. 1922 cleaning was necessitated by disinfectant having been put down closet by an inexperienced maid.
37	6'	2' 4'	2'	3'	.71	36 c.ft.	Yes	No	Subsurface irrigation in constantly cultivated land.	Domestic	—	4	—	56	W.C., kitchen sink and bath wastes	Apr. 1922	Not yet cleaned	—	—	Top exposed	—	Air inlets at end of subsurface lines. Outlets by vent pipes with exhaust cowls.	—	—	—	No	Analysis:— Cl 7.5 N as NH ₄ .12 N as Nitr. .25 N as Nitrite .07 O abs. 4.46 P (Parts) 100,000	Yes	Satisfactory
38.	8' Comp. 2' Camp	1' 9" diam. 1' 9" diam.	4' 0"	1' 6"	.98	13.3 c.ft.	Yes	No	Subsurface irrigation	Domestic	—	5	—	16.6	W.C. only	4 yrs ago	—	—	—	Immediately under privy seat	—	Iron vent pipe	—	—	—	—	—	No	Satisfactory.

B. Tanks which are stated to be not operating satisfactorily

10	9'	5' 4"	3' 2"	3' 4"	.73	94.7 c.ft.	Yes	No	Discharged into 4" S.W. pipes with open joints 12" below surface. Satisfactory.	Hospital	—	30	—	19.75	W.C., kitchen, bath and hospital wastes.	—	Apr. 1923	15 c.ft.	.5 c.ft.	Concrete slab	One M.H. at centre of tank	3" vent 10' high at inlet. 3" vent 2' 6" high at outlet.	8"	Not now	2"	Formerly, but not now	Fairly clear, light coloured	Yes.	Tank installed years ago when building was used as a private house, but it is not an up-to-date installation for an hospital.
11	10'	10'	4' 6"	6"	.93	270 c.ft.	Yes	Yes	Under ground, subsurface system. Satisfactory	Hospital	—	140	—	12.1	do.	1908	See Remarks	—	—	—	Two manholes	4" G.I. vent.	See Remarks	No	A few inches	No	Turbid. Light colour.	Yes.	Operation is satisfactory, but objectionable odours are sometimes caused by water ponding on the surface in wet weather. Scum removed every six months, 12" to 16" thick.
13	19'	19'	8'	5'	.38	2280 c.ft.	Yes	Yes	On surface, iron stone gravel. Vegetable garden. Satisfactory.	Hospital	—	240	—	59.4	do. (including much fatty matter)	1914	See Remarks	—	—	9" of soil	3 manholes	6" pipe	See Remarks	No	A few inches	Yes	Turbid, light colour. Poor quality.	Yes	Scum removed monthly so that from 6" to 12" remains in the tank. Satisfactory operation of the tank is impaired by the large proportion of fatty matter in the sewage. Poor quality of effluent attributed to the small size of the filter.
17	8'	8'	3' 6"	2' 6"	.61	70 c.ft.	No	Yes	Conveyed by pipe to open ditch in large paddock. Unsatisfactory. Land is sewage sick.	Hospital	28	20	12	2.2	W.C., kitchen, bath and operating theatre wastes. Also some disinfectants.	1919	Apr. 1922	Not known	Small quantity	—	Two manholes	2 goosenecks in filtration ch. Educt shaft from head of drain.	20" and 22"	At times	Not known	No	Fairly clear, light colour	Yes, but not satisfactory	Tank operating satisfactorily. Choking of inlet pipe is due to the excessive thickness of the blanket.
19	16'	11' 5'	5' 6"	4' 6"	.61	396 c.ft.	Yes	No	Discharged into a flowing stream. Satisfactory.	One Treatment Works.	—	60	—	41	W.C. only (P)	1918	June 1921	Not known	none	Timber and clay top	Top readily removed	None	4" to 5"	No	Seems to have none	No	Clear, light coloured	No, but no grease	Tends to gradually block up and cannot always be regarded as efficient.
21	18'	9'	5'	5'	.65	450 c.ft.	Yes	Yes	On surface of steep barren land. Satisfactory	Hotel and Domestic	60	33	6	85	W.C., household and rain waters	—	—	—	—	One manhole. Filtering ch. in First has no cover	No ventilation in First chamber	Scum and Sludge 48"	Yes	Scum and Sludge 48"	No	Clear and light coloured	No	Not satisfactory because the first chamber is almost full of solids. A new airtight cover should be placed over the filter chamber.	
23	8' 6"	4' 3"	5' 3"	3' 0"	.59	133 c.ft.	Yes	Yes	By underground drain to creek 1/2 mile distant, thence to river. Satisfactory	Hospital	40	26	24	32	W.C. only.	1919	Sept. 22	67 c.ft.	0	—	Two manholes	Two vents, both in 2nd chamber	3' solid bottom of tank	Yes	solid to surface	Yes	Turbid. Dark coloured	No	Unsatisfactory. Aerators have to be flushed out daily with clean water to prevent foul odours. Cleaned annually, about 67 c.ft. of sludge being removed at each cleaning.
24	17'	10' 7'	5'	3' 6"	.53	279 c.ft.	Yes	Not now	On surface of porous land.	Hospital	35	25	15	74	W.C. only	1921	Jan. 1922	175 c.ft.	0	—	One manhole. Filter chamber covered with 3 slabs	Only ventilation is between slabs on filter ch.	12"	No	1"	Not as good as might be.	clear, light coloured	No	Tank working well except that odours are not as good as might be. Filter at present disconnected from tank.
30	14'	8' 5' 6"	4'	4' 6"	.72	243 c.ft.	Yes (Rough Perspective)	No	Discharged on surface of clayey, low-lying soil which has been covered with cinders. Highly Unsatisfactory.	Hotel	26	18	8	8.4	W.C. only	1915 or 1916	Oct. 1922	162 c.ft.	—	—	—	—	none	—	18" to 24"	Yes	clear	—	Very unsatisfactory owing to bad location of tank, and great length and small fall of pipe, which frequently becomes badly choked. No scum forms. Notice has been given to discard this tank.
34	14'	9' 5'	4'	3'	.55	168 c.ft.	do	No	By drain pipe to Corporation main and thence to sea	Hotel	—	—	—	—	W.C. only	1912 (P)	—	—	—	Forms part of yard	Two manholes	Goose neck and ventilation shaft	24"	Yes	—	No	Clear, light coloured	—	Satisfactory except for clogging of inlet pipe. Has not been cleaned for three years
35	14'	6' 8'	4'	4' 5"	.71	247 c.ft.	do	No	Soakage pit	Hotel	26	17	8	91	W.C. only	1904	not known	—	—	—	One manhole over partition	Goose necks vent pipe 7'	—	Yes	—	No	Fairly clear slightly smoky	—	Has worked very well. Not cleaned in last 5 1/2 years. Choking of inlet pipe and difficulty of getting rid of effluent in wet weather are the only troubles.

C. Tanks regarding which nothing is stated as to satisfactoriness of operation.

16	16'	16'	4' 6"	5' 4"	.59	774 c.ft.	Yes	Yes	Into underground drain and thence to soakage pit. Satisfactory	Hotel	50 (Amos tank used at a time)	120 (8 mos) to 48	20	W.C., kitchen hotel, and bath wastes.	1913	1922	See Remarks	9" layer of soil and turf	4 Manholes	6" G.I. pipe and exhaust vent	See Remarks	No	A few inches	No	Clear	Yes	Scum is allowed to accumulate to a thickness of 12" to 18" and then half is removed. Generally about once a year.
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